

*Notes upon certain Doubtful Star-Places.* By Professor Truman Henry Safford.

In compiling a star-catalogue which is to possess great precision at the present epoch, it is often found that the proper motion is at fault. So that if we test the position for some past epoch, we find it very accurate; most accurate for the mean epoch according to weights of the original observations; and nearly as precise for the mean epoch according to weights of the modern observations employed: for the best class of compiled catalogues this epoch will be about 1865, or a few years earlier or later.

The difficulty of obtaining precise proper motions is now but small for Bradley's stars, if they were observed four or five times in each coordinate by himself, and is much greater, in Right Ascension at least, for those stars which were first observed by Piazzi, Lalande, or Groombridge, unless, indeed, they happen to be contained in those more precise catalogues which we owe to Struve, Bessel, or Argelander, a few years later.

For Piazzi and Groombridge were in the habit of adjusting their Transit instruments to a mark, and these adjustments were not often enough repeated for security. Moreover, I have noticed with portable instruments that a reaction sometimes takes place after an adjustment, owing perhaps to the state of molecular strain which the movement of a stiff adjusting screw, little used, may cause in the instruments; so that the parts are quite liable to spring some hours after the exact adjustment has been effected. Be this as it may, it is certain that Piazzi's Transit and even Pond's were frequently several seconds of arc out of the meridian; so that it is not to be wondered at if proper motions derived from these astronomers' catalogues are in error.

In volume iv. of the *Annals* of Harvard College Observatory will be found a catalogue of Right Ascensions, including many close polars, which was planned by myself with a view to establishing a standard secondary catalogue for 1865. I have now in hand, with the Repsold Meridian Circle (just commencing its work) of this Observatory, a similar catalogue, a small portion of which has been sent to press; and the intention of the first portion of this catalogue is to enable me to discuss these close polars more fully, in order to get a better basis for the observations in Right Ascension of the early part of this century. Very fortunately there are observations about 1815 by W. Struve, partly reduced, which will enable us to discuss Piazzi's and Groombridge's Right Ascensions with more thoroughness, provided we have good modern determinations for the sake of the proper motions. Of course Auwers's Bradley furnishes us with an admirable series of Right Ascensions for 1755; but many of Groombridge's stars, observed also by Struve, are not contained in that work.

Another aim of my present work is to revise and clear up a good many discrepancies which I have found from time to time in the catalogues. In some cases new observations are needed for this purpose: in many others it seems only necessary to bring together data already accumulated, and show whence discrepancies have arisen.

The set which I shall notice in this paper includes twelve stars from the fundamental catalogue compiled by Professor Auwers in Publication XIV. of the *Astronomische Gesellschaft*; these twelve are noted by Prof. W. A. Rogers as discordant in Right Ascension from his own observations in a paper contained in vol. x. of the *Memoirs* of the American Academy, pages 389 to 428; this paper will be cited as R., and the fundamental catalogue as A.

The 12 stars are

- |                       |                       |
|-----------------------|-----------------------|
| 1. Bradley 6,         | 7. $\eta$ Draconis,   |
| 2. $\eta$ Cassiopeiæ, | 8. Groombridge 2377,  |
| 3. 36 Camelopardi,    | 9. $\beta$ Lyre,      |
| 4. 1 H. Draconis,     | 10. Groombridge 2900, |
| 5. Groombridge 2164,  | 11. $\nu$ Pegasi,     |
| 6. $\theta$ Draconis, |                       |

and the star *b Draconis*; for which Prof. Rogers gives no details in this paper, except on page 412.

By referring to volumes x. and xii. of the *Harvard Observatory Annals*, we find Prof. Auwers has already included all these observations of *b Draconis* in his catalogue; and that the discrepancy did not seem to him to warrant either the exclusion of any observations or any further remark.

Of the remaining eleven stars, Nos. 2, 9, and 11 have been well observed by Bradley, and their proper motions are quite certain. No. 2 is double, and has a pretty large annual proper motion. It was also observed by Prof. Rogers for the most part within about a minute of a preceding star— $\zeta$  *Andromedæ*. Under these circumstances there is no great singularity in the difference

$$A - R = -0.090^s \text{ (12 observations);}$$

especially as the fifteen observations made at Cambridge between 1863 and 1865 give

$$A - \text{Annals, vol. iv.} = +0.032^s,$$

or with systematic correction according to Prof. Rogers

$$A - \text{Annals, vol. iv.} = -0.024^s;$$

whether we consider these discrepancies as due to personal equation, orbital motion, or too great hurry in observation.

Nos. 9 and 11 are discrepant from A. because of errors of computation. The Right Ascensions for 1875.0 in Prof. Rogers's catalogue in volume xii. of the *Annals* should be

$$\begin{array}{c} \text{h} \quad \text{m} \quad \text{s} \\ 18 \quad 45 \quad 27.853 \end{array}$$

and

$$\begin{array}{c} \text{h} \quad \text{m} \quad \text{s} \\ 23 \quad 19 \quad 8.520, \end{array}$$

instead of  $27^{\text{s}}.774$  and  $8^{\text{s}}.400$  respectively; leaving as discrepancies  $+0^{\text{s}}.007$  and  $-0^{\text{s}}.024$ , instead of  $+0^{\text{s}}.086$  and  $+0^{\text{s}}.096$ .

None of the remaining eight stars were observed in Right Ascension by Bradley; although four were in Declination. Nos. 5, 8, and 10 have been thoroughly investigated by Argelander, with respect to proper motion; and I see no chance of great error in this element. I have therefore brought up the available newer Right Ascensions of these stars—seconds only—with Argelander's proper motions, as corrected by Auwers for the difference of precession-constants, and with Auwers's or Rogers's systematic corrections, slightly modifying the latter (as I do not understand his Table III. in volume xii. of the *Annals*, and its form is unusual in similar discussions), with the following results, in seconds of time (N. denotes number of observations, W. weight):—

|                   | Gr. 2164.           |    |    | Gr. 2377.           |    |    | Gr. 2900.      |    |    |
|-------------------|---------------------|----|----|---------------------|----|----|----------------|----|----|
|                   | A.                  | N. | W. | A.                  | N. | W. | A.             | N. | W. |
| Greenwich 1861    | <sup>s</sup> 16.036 | 3  | 1  | <sup>s</sup> 55.720 | 5  | 2  | <sup>s</sup> — |    |    |
| Harv. Coll. 1865  | 16.129              | 28 | 3  | —                   |    |    | 12.972         | 10 | 2  |
| Argelander 1866   | —                   |    |    | 55.744              | 8  | 3  | —              |    |    |
| Engelmann 1866    | —                   |    |    | 55.741              | 8  | 3  | —              |    |    |
| Pulcova 1871 ...  | 16.068              | —  | 5  | 55.724              | —  | 5  | 12.997         | —  | 5  |
| Greenwich 1872    | —                   |    |    | 55.705              | 5  | 2  | 12.747         | 5  | 2  |
| Harv. Coll. 1872* | 16.264              | 5  | 2  | 55.719              | 5  | 2  | —              |    |    |
| „ 1875†           | 16.196              | 5  | 2  | 55.637              | 22 | 3  | 13.082         | 5  | 2  |
| Mean ...          | 16.105              |    | 11 | 55.713              |    | 18 | 12.962         |    | 11 |

The final deviations of Harvard College 1875 are respectively

$$\begin{array}{ccc} \text{ } & \text{ } & \text{ } \\ \text{ } & \text{ } & \text{ } \\ \text{ } & \text{ } & \text{ } \end{array} \begin{array}{ccc} \text{ } & \text{ } & \text{ } \\ \text{ } & \text{ } & \text{ } \\ \text{ } & \text{ } & \text{ } \end{array} \begin{array}{ccc} \text{ } & \text{ } & \text{ } \\ \text{ } & \text{ } & \text{ } \\ \text{ } & \text{ } & \text{ } \end{array}$$

instead of

$$\begin{array}{ccc} \text{ } & \text{ } & \text{ } \\ \text{ } & \text{ } & \text{ } \\ \text{ } & \text{ } & \text{ } \end{array} \begin{array}{ccc} \text{ } & \text{ } & \text{ } \\ \text{ } & \text{ } & \text{ } \\ \text{ } & \text{ } & \text{ } \end{array} \begin{array}{ccc} \text{ } & \text{ } & \text{ } \\ \text{ } & \text{ } & \text{ } \\ \text{ } & \text{ } & \text{ } \end{array}$$

\* From Auwers.

† With Rogers's systematic correction, as given by himself. This number includes the observations of the preceding line, which are omitted in taking the mean.

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Neither set of discrepancies seem excessive, considering the Declinations of the three stars

$$59^{\circ}8, \quad 57^{\circ}0, \quad \text{and} \quad 79^{\circ}4.$$

Of the remaining five stars, four are in Bradley's catalogue, but not observed in Right Ascension. The proper motions of these are given by Prof. Auwers as rather insecure; they are not very important as fundamental stars, and I give simply the corrections which the Right Ascension of A. seems to need, from a rough comparison of the available material.

|                      |     |   |            |
|----------------------|-----|---|------------|
| Bradley 6 ...        | ... | $+0^{\text{s}}.108 + 0^{\text{s}}.019$  | $(t-1875)$ |
| 36 Camelopardi ...   | ... | $+0^{\text{s}}.050 + 0^{\text{s}}.0053$ | $(t-1875)$ |
| $\theta$ Draconis... | ... | $-0^{\text{s}}.037 - 0^{\text{s}}.0030$ | $(t-1875)$ |
| $\eta$ Draconis      | ... | $-0^{\text{s}}.076 - 0^{\text{s}}.0060$ | $(t-1875)$ |

These diminish Prof. Rogers's discrepancies from

$$-0^{\text{s}}.170; -0^{\text{s}}.100; +0^{\text{s}}.093; +0^{\text{s}}.141,$$

to

$$-0^{\text{s}}.055; -0^{\text{s}}.049; +0^{\text{s}}.059; +0^{\text{s}}.072;$$

leaving nothing greater than  $0^{\text{s}}.034$  sec  $\delta$ . The largest discrepancy of all, Groombridge 2164, when reduced to the equator is

$$0^{\text{s}}.046 \text{ sec } \delta.$$

As the probable error of one Right Ascension in the catalogue of volume xii. is given as

$$\pm 0^{\text{s}}.013 \text{ sec } \delta,$$

there is nothing very remarkable in the amount of the final difference.

The last star,  $\iota$  *Draconis* H, is an important polar. Its magnitude is 4.3; it is within  $8^{\circ}.2$  of the north pole, and in a region ( $9^{\text{h}}$ ) of A.R. where other good polars are few; but the observations early in this century are not very accordant. The following five values have been assigned to its annual proper motion by as many astronomers; in each case from a full discussion (probably by least squares) of all available material up to about 1860 or later.

|              |     |                      |
|--------------|-----|----------------------|
| Gould ...    | ... | $-0^{\text{s}}.0077$ |
| Safford ...  | ... | $+0^{\text{s}}.005$  |
| Wagner ...   | ... | $0^{\text{s}}.000$   |
| Albrecht ... | ... | $-0^{\text{s}}.018$  |
| Auwers ...   | ... | $-0^{\text{s}}.0174$ |

The cause of these differences lies, probably, in the different weights given to Groombridge, and perhaps Piazzzi, or the retention or exclusion of one of them. The mean of all these values,  $-0^{\circ}.0076$ , agrees nearest with Dr. Gould's, which I shall retain; with this, the following are the Right Ascensions from the authorities of Publication XIV. and some later:—

|                       | A. |    |                   | N. | W. |
|-----------------------|----|----|-------------------|----|----|
|                       | h  | m  | s                 |    |    |
| Pulcova 1846.9 ...    | 9  | 19 | 5.90              | 49 | 4  |
| Washington 1863.5 ... |    |    | 5.80              | 13 | 2  |
| Greenwich 1864.2 ...  |    |    | 5.86              | 6  | 2  |
| Harvard Coll. 1864.5  |    |    | 6.02              | 38 | 3  |
| Pulcova 1865... ...   |    |    | 5.90              | —  | 7  |
| Greenwich 1870.7 ...  |    |    | 5.65              | 7  | 2  |
| Harvard Coll. 1872.9  |    |    | 5.95              | 28 | 3  |
| Berlin 1874.8 ...     |    |    | 5.99              | 18 | 3  |
| Williamstown 1882.8   |    |    | 5.98              | 7  | 2  |
| Mean ... ..           | 9  | 19 | 5.906 $\pm$ 0.022 |    | 28 |

This probable error holds good for 1867; the correction to A. will be—

$$+ 0^{\circ}.166 + 0^{\circ}.0097 (t - 1875).$$

The Williamstown observations were made for the purpose of obtaining the instrumental corrections, and were reduced by neighbouring polars from A.; the instrument was the Repsold Meridian Circle of this Observatory.

It is much to be desired that this star should be pretty thoroughly observed; I have among my note-books a result of observations at Montsouris, which give for 1875

$$\begin{matrix} h & m & s \\ 9 & 19 & 5.71 \end{matrix} \text{ (70 observations),}$$

but have not the original at hand to refer to; including it with a weight=3, we should have as final result for 1875.0

$$\begin{matrix} h & m & s & s \\ 9 & 19 & 5.887 & \pm 0.023. \end{matrix}$$

*Williamstown, Mass. :*  
1883, Feb. 21.